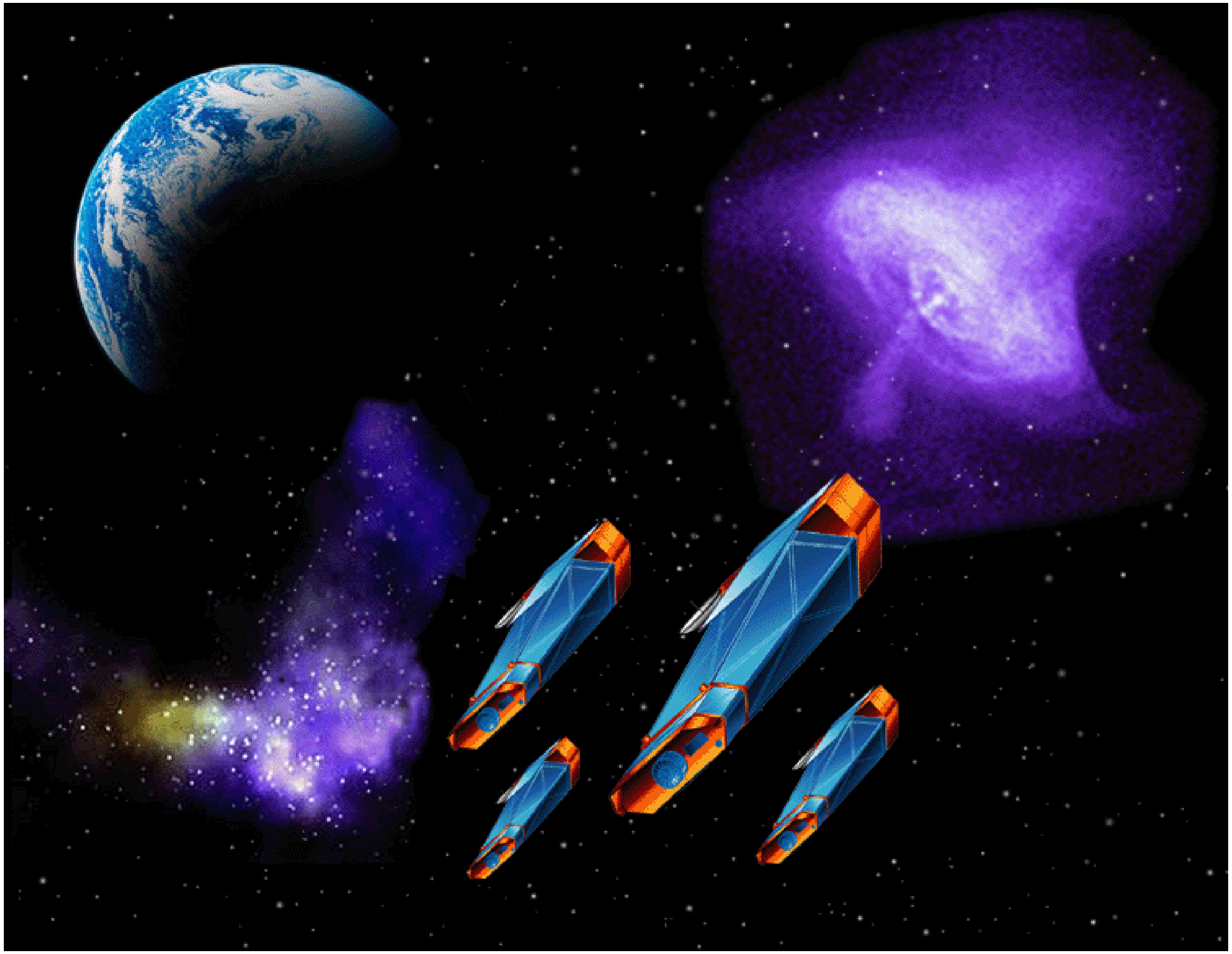
Con-X Spectroscopy X-Ray Telescope

Rob Petre, GSFC,SXT IPT Lead

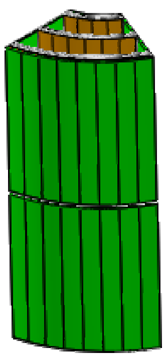


Constellation-X Requirements Flow Down

Science Goals	Measurement Capabilities	Engineering Implications	Key Technologies
Parameters of Supermassive Black Holes **Search for Dark Matter** **Investigate Faint Sources** **Plasma Diagnostics from Stars to Clusters**	**Effective area:** *15,000 cm^2 at 1 keV* *6,000 cm^2 at 6.4 keV* 1,500 cm^2 at 40 keV **Band pass:** 0.25 to 40 keV **Spectral resolving power (E/ΔE):** *≥ 300 from 0.25 to 6.0 keV* ≥ 3000 at 6 keV ≥ 10 at 40 keV **System angular resolution and FOV:** *15 arc sec HPD and FOV > 2.5' (0.25 to 10 keV)* 1 arc min HPD and FOV > 8' (10 to 40 keV)	**Effective area:** • *Light weight, highly nested, large diameter (1.6 m) optics* • *Long focal length (8-10 m)* **Band pass:** • 2 types of telescopes to cover energy range **Spectral resolving power:** • *Dispersive* and non-dispersive *capability* to cover energy band **System angular resolution and FOV:** • *Tight tolerances on telescope figure, surface finish, alignment* • ≥ 30 x 30 array for x-ray calorimeter (pixels ~5") • Cryocooler driven by array size and readout electronics	**High throughput optics:** • *High performance replicated segments and shells* • *High reflectance coatings* • *High strength/mass materials for optical surfaces* **High energy band:** • Multilayer optics • CdZnTe detectors **High spectral resolution:** • 2 eV calorimeter arrays • Coolers • Lightweight gratings • CCD arrays extending to 0.25 keV **Optical bench:** • Stable (time and temp.) • High strength/low weight materials

SXT Mirror Phased Development

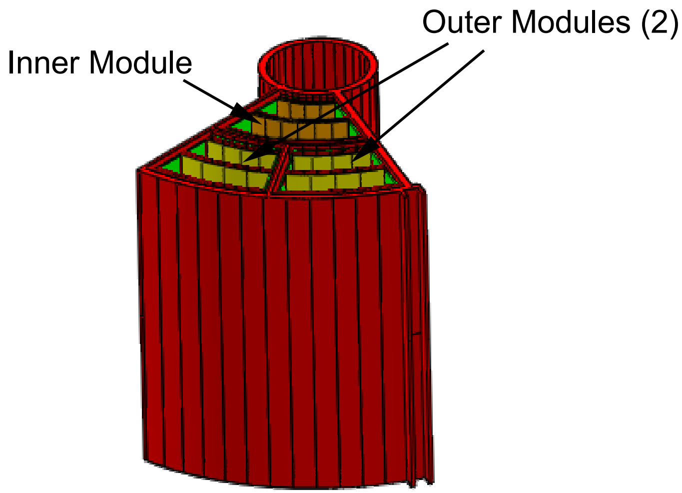
Engineering Unit and Optical Alignment Pathfinder



Single inner module with

- 0.5 m dia. reflector pair (replicated from Zeiss precision mandrel)
- Parabolic (P) and Hyperbolic (H) submodules
- First modules to be aligned using etched silicon microcombs

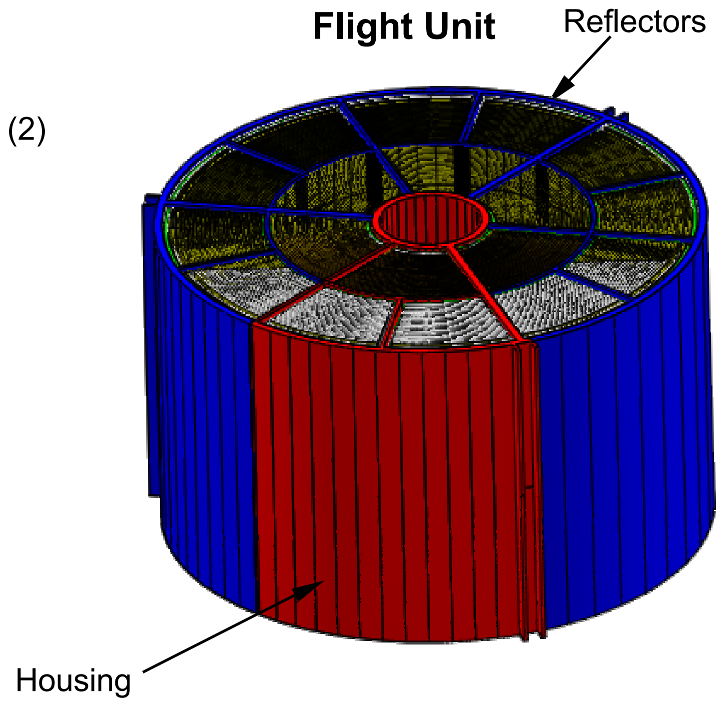
Prototype Unit



Flight scale assembly of

- 3 modules (2 outer and 1 inner)
- Largest diameter same as for flight - 1.6 m
- Each module has 3 to 9 reflector pairs
- Demonstrates module to module alignment

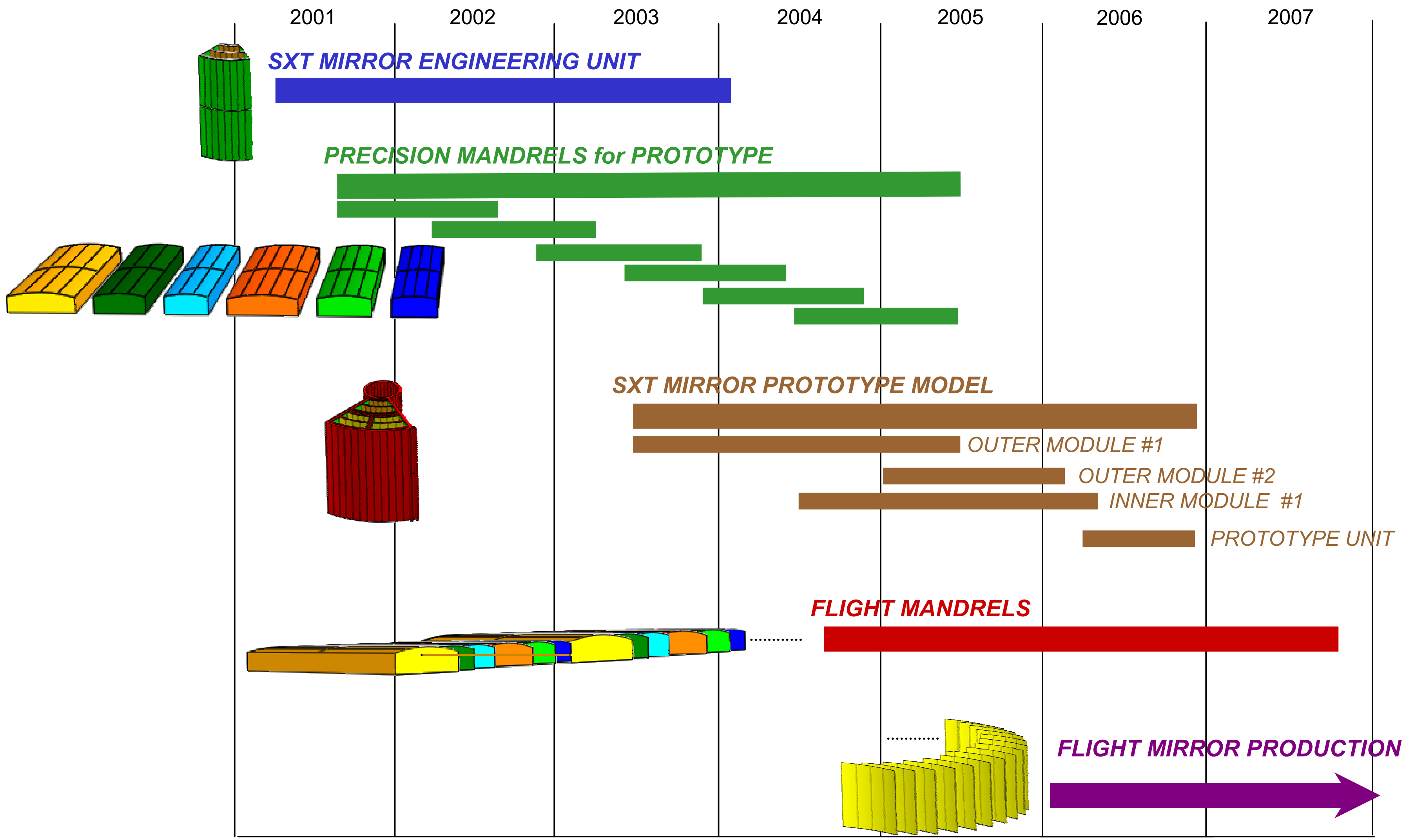
Flight Unit



Full flight Assembly

- 1.6 m outer diameter
- 18 Small Modules
- 0.2 - 0.5 m segment length
- 70 to 220 reflector diameters

SXT Technology Roadmap

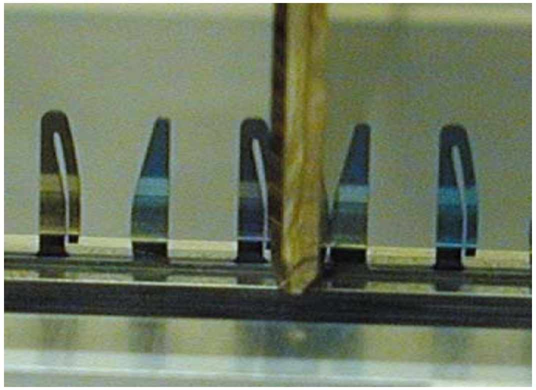


SXT Prototype Development

	Optical Assembly Pathfinder		Eng. Unit	Prototype		
Configuration						
Module Type	**Inner**	**Inner**	**Inner**	**Outer**	**Inner**	**Outer & Inner**
Housing Material	**Aluminum**	**Titanium**	**Composite**	**Composite**	**Composite**	**Composite**
Focal Length	**8.5m**	**8.5m**	**8.5m**	**10.0m**	**10.0m**	**10.0m**
Reflector Length (P&H)	**2 x 20 cm**	**2 x 20 cm**	**2 x 20 cm**	**2 x 50 cm (TBR)**	**2 x 50 cm (TBR)**	**2 x 50 cm (TBR)**
Nominal Reflector Diameter(s)	**50 cm**	**50 cm±**	**50 cm±**	**160 cm± 120 cm± 100 cm±**	**90 cm± (TBR) 70 cm± (TBR) 50 cm± (TBR)**	**160 cm± 40 cm± 120 cm± 70 cm± 100 cm± 50 cm±**
Goals	▪Align 1 optical surface pair (P&H) ▪Evaluate optic alignment techniques, optics assembly design & process, & optics metrology	▪Align up to 3 optical surface pairs (3P,3H) ▪Evaluate tooling and alignment techniques for mass production schemes	▪Align 3 optical surface pairs to achieve <10 arc sec. ▪Environmental and X-ray test	▪Flight-like configuration outer module ▪Largest optical surfaces ▪Environmental and X-ray test	▪Flight-like configuration inner module ▪Environmental (TBR) and X-ray test	▪Demonstrate module to module alignment ▪Environmental and X-ray test
Timeframe	**Q4 of FY02**	**Q2 of FY03**	**Q1 of FY04**	**Q4 of FY05**	**Q3 of FY06**	**Q4 of FY06**

SXT Mirror Status

- **Current effort focused on OAP1**
  - Glass forming and replication process well established
    - Figure of small reflectors (20 cm dia.) within a factor of 2 of requirement
  - Infrastructure nearly in place for 50 cm reflector forming and replication
    - Forming & replication mandrels delivered, oven & replication station operational, cutting fixture and spay booth being assembled
  - Al housings being assembled
  - Metrology & alignment approach defined; awaiting refurbished CDA from Bauer
- **Efforts underway to prepare for future OAPs and Prototype**
  - Large segment replication mandrels on order (Zeiss)
    - 1.6, 1.2, 1.0 m diameter; first delivery in August 2002
  - Prototype Si alignment structures developed by MIT
    - Existing structures compatible with OAP optical design
    - Provide inter-reflector alignment accuracy of ~0.1µm
  - RFI released for large forming mandrels
  - Metrology facilities and other facilities being upgraded



Etched Si alignment microcomb

SXT Mirror Development Team

- **Multi-institutional participation**
  - GSFC
    - IPT leadership and management
    - Mirror design and error budgeting
    - Substrate forming and reflector replication
    - Housing design and assembly
    - Reflector and module metrology
  - MSFC
    - X-ray calibration
    - Mandrel procurement support
    - Mandrel metrology
  - MIT
    - Precision microlithography (alignment structures)
  - SAO
    - Management support
    - Systems engineering
  - Industry partners
    - Zeiss (precision mandrels), Bauer (metrology), Rodriguez (forming mandrels)

SXT Mirror Presentations

Overview	Rob Petre (GSFC)
Technical and performance requirements	Bill Podgorsky (SAO)
Substrates	Will Zhang (GSFC)
Mounting and alignment	Jeff Stewart (GSFC)
Metrology	Dave Content (GSFC)
Centroid Detector Assembly	Paul Glenn (Bauer)
MSFC Activities	Steve O'Dell (MSFC)